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Automotive Engineer
26811 NE Highland Meadows Drive
Vancouver, WA 98682

June 20, 2018

Attention: Mr. Jason Robinson, Esq.

Re: **Faust v General Motors**

Dear Mr. Robinson,

At your request, I have performed a crashworthiness analysis of the automobile accident involving the 2012 Chevrolet Malibu in which K█████ F█████, the front seat passenger of the vehicle, was fatally injured. This report details my opinions to date, the facts and data that I have considered in forming said opinions, and the basis and reasons for my opinions. Additionally, attached as exhibits to this report are the following: (1) my curriculum vitae (CV), which details my knowledge, skill, experience, training, and education in the fields of engineering, crashworthiness analysis, and vehicle design analysis; (2) a list of other cases in which, during the previous four years, I have testified as an expert at trial or by deposition; and (3) my billing schedule.

Prior to stating my opinions, however, and although my CV more fully details my knowledge, skill, experience, training, and education in the fields of engineering, crashworthiness analysis, and vehicle design analysis, below is a brief outline of portions of my education, training, and experience with crashworthiness and vehicle design analysis that applies to the particular disciplines required to effectively render opinions in this case.

I. Background and Qualifications

- A. I received a Bachelor's degree in Mechanical Engineering from General Motors' Institute (GMI, now Kettering University) in 1981. At GMI, I was enrolled in the "Automotive Option" curriculum.
- B. I have experience with the product creation process within large organizations, including Chrysler and Ford.
- C. While employed by a variety of automobile manufacturers, I have been responsible for and participated at various levels in the design, analysis, testing, and development of almost every vehicle system. Indeed, my expertise includes the field of automotive design analysis engineering – the specialty of analyzing the design and performance of vehicles. I have been responsible for analyzing crash tests, sled tests, and field performance of various vehicles and crashworthiness systems.

- D. For instance, I was the Chief Engineer for the Ford GT, initially produced as a 2005 model. In this role, I was responsible for all aspects of the safety performance of the Ford GT. This included drafting and approving the plan for all safety testing (vehicle, sled and component testing). I also was the architect for the main structure of the vehicle and was responsible for all structural design, analysis, testing and development. I also was responsible for the setting of targets for safety performance, including roof crush. The requirements that I set for the Ford GT roof included meeting FIA Appendix J, which results in a much stronger roof than the minimal FMVSS 216 requirement.
- E. As the Executive Director of Engineering at McLaren Cars Ltd., one of my responsibilities was the design, analysis, testing, and development of a convertible version of the Mercedes-McLaren SLR. This was an innovative design process due to the fact that the main structure of the SLR is constructed from Carbon-Fibre material. Design targets were set by Mercedes that exceeded the minimum legislative requirements in all markets that the SLR was sold in, with special emphasis on the US market requirements. Also, while employed at McLaren I was responsible for the overall crash test program for the Mercedes-McLaren SLR Convertible and another vehicle. I was also responsible for developing significant computer simulation analysis techniques that were useful in the development of the Mercedes-McLaren SLR Convertible. The analysis was used for both roof crush and crash testing simulation. The analysis was validated by component and vehicle tests. The Mercedes-McLaren SLR Convertible included “advanced” airbags for the FMVSS 208 standard revised for 2008 model year vehicles. McLaren constructed an FMVSS roof crush test fixture and ran many tests, which I was able to review.
- F. As the Vice President of Manufacturing and Program Management at Aptera I set the vehicle and system level safety targets. Since the Aptera was technically a motorcycle, the minimum automotive standards far exceeded what would have been required. Due to the fact that customer perception of the Aptera was “car-like”, automotive criteria was considered in all aspects. Legally, safety belts are not required on a motorcycle. However, the Aptera was designed with safety belts. While at Aptera I was the seat and safety belt system design and release engineer. While the Aptera did not become a production vehicle, I had still designed the safety belt for that vehicle. Most safety belt and airbag system designs are integrations of existing components that are tuned to function as intended for each specific vehicle.
- G. While employed as a suspension design supervisor at Chrysler Corporation I lead a team that developed an FMEA for suspensions at a system level. I also participated on a team working on an FMEA for a run-flat tire. I was also the vehicle development engineer for the Dodge Viper. As part of the Viper team I was responsible for all vehicle level testing and evaluation. As a development engineer I did a significant amount of vehicle level testing and evaluation. In addition to being involved with running legislative vehicle tests I also evaluated vehicles for customer usage. The customer usage and possible miss-use was considered and vehicles were evaluated for their performance in these situations that are not defined, legislative required tests. I also performed legislated vehicle tests for other markets, such as Europe and Asia.
- H. While employed at Minicars I conducted many different types of full vehicle crash tests, sled tests, and component tests. These tests included a wide variety of subjects ranging from highway crash attenuators, side impacts with 2 moving vehicles, sled tests to study steering columns, and aircraft seats. Specific testing for safety belts was performed using an Instron test machine. I designed, developed and tested an airbag system for the

purpose of landing a military target drone. Minicars was contracted to perform that work as a result of the company-wide experience with airbags. It was my job to design this very specific airbag, which used a cold gas generator, similar to the concept for many side curtain airbags currently in automotive vehicles.

- I. Over the years I have seen thousands of documents from various automobile manufacturers regarding various safety testing, and I have reviewed hundreds (if not thousands) of Society of Automotive Engineers (SAE) papers. Additionally, I have seen hundreds of thousands—if not millions—of confidential, proprietary documents from almost every vehicle manufacturer in the world regarding automotive design, manufacturing, and testing.
- J. I have over 40 years experience, training and education as an automotive engineer. Most of this experience has been in the design, development and analysis of many types of vehicles. I have worked for all of the major US automotive manufacturers: Chrysler, General Motors, and Ford. In addition I have worked for numerous small and start up automotive manufacturers.
- K. It has been part of my background and training to:
 - 1. Utilize general mechanical engineering knowledge and skills, including numerous principles of the laws of physics and their application to the operation of mechanical objects.
 - 2. Utilize special knowledge of automotive engineering, including knowledge of principles of physics and mechanical engineering, as applied to the design, manufacture and performance of automobiles and component parts.
 - 3. Utilize special background and training in principles of design and analysis of design of automotive restraint systems and the performance of automotive restraint systems:
 - a. In the testing environment;
 - b. In studying the relationship between testing and “real world/ field” performance based on testing and analysis of testing; and
 - c. In actual “real world” collisions.

II. Development and Testing Experience

- A. While employed at Minicars, I conducted many different types of full vehicle crash tests, sled tests and component tests. These tests included a wide variety of subjects ranging from highway crash attenuators, side impacts with two moving vehicles, sled tests to study steering columns and aircraft seats.
- B. While employed at McLaren, I was responsible for the overall crash test program for the Mercedes-McLaren SLR convertible and another vehicle. I was also responsible for developing significant computer simulation analysis techniques that were useful in the development of the Mercedes-McLaren SLR convertible. The analysis was used for both roof crush and crash testing simulation. The analysis was validated by component and

vehicle tests. The Mercedes-McLaren SLR convertible included “advanced” airbags for the FMVSS 208 standard revised for 2008 model year vehicles. McLaren constructed an FMVSS roof crush test fixture and ran many tests, which I was able to review.

- C. While employed at Aptera, I set the requirements for roof crush at 4 times vehicle weight, which is well above the 1.5 times that was required for FMVSS 216 at that time. Aptera had already constructed an “in-house” FMVSS 216 test fixture. I was able to review many tests run on Aptera prototypes.
- D. In addition to my testing experience while working for various automotive manufacturers, in the litigation context I have seen literally thousands of crash tests.

III. Assignment and Methodology

- A. As noted earlier, I was asked to perform a crashworthiness analysis of the automobile accident involving the 2012 Chevrolet Malibu in which K [REDACTED] F [REDACTED], the front seat passenger of the vehicle, was fatally injured.
- B. The assignment was accomplished using methods commonly accepted and used by automotive engineers who are similarly engaged in the profession of accident analysis and crashworthiness analysis.
- C. The analysis I use includes differential diagnosis to “rule out” unlikely scenarios prior to developing my theory. This is similar to what a physician does to make a diagnosis.
- D. I began this analysis with a thorough inspection of the subject vehicle and continued with a review of available material (both public material and material produced in discovery in this case) to develop a theory as to the cause of the accident, which resulted in the fatal injuries to K [REDACTED] F [REDACTED].
- E. I followed a scientific method to perform this analysis. It included the following engineering steps:
 - 1. Detailed macroscopic study of the available physical evidence, and a review of all available material related to the accident in question.
 - 2. A review of published research material regarding the design of the subject vehicle;
 - 3. An examination of material relating to other similar incidents and claims.
 - 4. A review of technical drawings.
 - 5. A review of various tests conducted on the subject vehicle.
 - 6. A review of any other documents produced by other manufacturers in similar incidences.
 - 7. A review of other designs, which General Motors could have used and which would have been safer.
- F. In this case I did not perform any of my own vehicle crash tests because it was not necessary. Instead I have been able to rely on numerous tests performed by others, such as the Insurance Institute for Highway Safety (IIHS), the National Highway Traffic Safety Administration (NHTSA) and, in certain cases, other vehicle manufacturers.

IV. Crashworthiness

- A. Crashworthiness is the science of preventing or minimizing serious injuries and fatalities in automobile accidents through the use of a vehicle's safety systems. There are five (5) recognized crashworthiness principles in the automobile industry. They are as follows as shown below in Figure 1:



Figure 1 - Vehicle Crashworthiness Principles

- B. When the National Highway Traffic Safety Administration (NHTSA) created the Federal Motor Vehicle Safety Standard (FMVSS) in the late 1960's, the preamble to the safety standards included a crashworthiness definition similar to that used above, "that the public is protected against unreasonable risk of crashes occurring as a result of the design, construction, or performance of motor vehicles and is also protected against unreasonable risk of death or injury in the event crashes do occur."
- C. The National Transportation Safety Board (NTSB) has also stated that, "Vehicle crashworthiness refers to the capacity of a vehicle to protect its occupants from crash forces. This protection—which is achieved, in part, by vehicle structure—includes maintaining a survival space around the occupant, retaining the occupant within that space, and reducing the forces applied to the occupant."
- D. The first four crashworthiness principles have their genesis in corresponding techniques of product packaging for shipment. The typical television, for example, is packed in a heavy corrugated cardboard box, which is held closed with adhesives and staples, and molded Styrofoam surrounds the TV. Therefore, the cardboard box prevents ejection, maintains survival space and manages impact energy. The Styrofoam provides restraint and padding.
- E. One of the pioneers in crash safety, Hugh de Haven, was instrumental in applying these principles to light aircraft and, later, automobiles. Two of these principles form the basis of Mercedes Benz' famous patent (featured in their print and TV advertisements) which identifies a strong passenger "safety cell" to maintain survival space and crushable front and rear structures to manage the collision energy.

- F. John Paul Stapp would later evaluate crashworthiness principles by conducting tests with volunteers. Colonel Stapp undertook this effort, as he was tired of losing soldiers in the field who survived the accident but died of fire related injuries. Much of the crashworthiness improvements we see on vehicles today were developed for the aerospace and racing industry and that technology then translates into production vehicles.
- G. It can be said that crashworthiness principles work together like links in a chain. If one safety systems fails, this can cause the other safety systems to fail or be ineffective.
- H. Crashworthiness safety systems do not prevent accidents from happening. Rather, crashworthiness safety principles prevent and minimize injuries following an accident. Hence, there is a distinction between the cause of an accident versus the cause of injuries. A classic example of this distinction is the Titanic.¹

V. Duty to Make a Safe Vehicle

- A. In 1993, General Motors stated, “Safety isn’t one thing. It’s everything.”
- B. Mary Barra, CEO of General Motors, testified to Congress in 2014 that, “Our customers and their safety are at the center of everything we do.” Ms. Barra also testified to Congress that General Motors was dedicated to putting the highest-quality and safest vehicles on the road.
- C. Jeff Boyer, Vice-President of Global Vehicle Safety at General Motors, has stated, “Nothing is more important than the safety of our customers in the vehicles they drive.”
- D. General Motors has also stated in the past that, “The rich don’t deserve to be safer ... Isn’t it time we realized safety is not just for the pampered and the privileged? Safety is for all.”
- E. Ford has stated in the past that it is so obsessed with safety that only a person’s mother is more obsessed with that person’s safety than Ford.
- F. Ford testified under oath on March 21, 2001, that Ford “has a moral obligation to do those things that are feasible and practical to reduce the risk of injury and death to customers.” This past testimony was recently affirmed by Ford, under oath, on May 16, 2017.
- G. Lee Iacocca, former President of Ford Motor Company stated, while President and CEO of Chrysler, that “Every American has the right to a safe vehicle.” Gerald Greenwald,

¹ While the cause of hitting the iceberg has been the subject of much debate (inattentiveness, the captain was drunk, perhaps they were going too fast, etc.), there is no question that almost every passenger that entered a lifeboat that night lived, while almost all of those who went in the water died. Accordingly, had the Titanic had enough lifeboats on board (i.e., the boat’s “safety systems”), almost all (if not all) of the people on-board would probably have lived. So the cause of the sinking (the accident) is irrelevant vis-à-vis how everyone died. What’s important is how the safety systems worked (or didn’t work) following the accident.

chairman of Chrysler, then sent a letter to every Chrysler dealership in 1988 stating that Chrysler intended to honor that right. See below (Figure 2):



G. Greenwood
Chairman

October 6, 1988

To: All Chrysler Motors Dealers

Subject: Bill of Rights - The Right To A Safe Car

As you know, Lee Iacocca announced the Car Buyer's Bill of Rights Program at our Dealer Announcement Show in Honolulu. One of the planks of the Bill of Rights is the right to a safe vehicle. Chrysler Motors intends to honor that right and has committed enormous resources to building safe cars with:

- Air bags as standard equipment on Fifth Avenue, LaBaron Coupe, Daytona, Gran Fury and Diplomat. By 1990, Chrysler will feature driver-side air bags on every car it builds in the United States.
- Over 30 safety features standard in every Chrysler car and more coming.
- Safety Shield Program to identify which components are safety components and how much importance we place on each of them.

Occupant protection is one of the primary goals in our safety program and one of the "rights" we promise our buyers. You, the dealer, and your sales staff, are the key to getting this message across to the consumer. Your role is vital in:

- explaining the features and operation of air bag systems;
- demonstrating the proper use of front and rear belt systems; selling dealer installed rear seat shoulder belts to your new car and service customers;
- telling your customers about the availability of child seat tether strap anchors, how they can get anchor hardware kits and how they can use child car seats in the front passenger seat, as well as in the rear.

The Owner's Manual indicates the availability and the proper usage of all safety equipment. It is important that your staff be familiar with the details for discussions with customers and outside groups who may inquire.

Furthermore, your personnel should be aware that tampering with any feature required by a safety standard is a violation of Federal law and can result in civil penalties to your dealership.

The Bill of Rights is the foundation for Chrysler Motors' commitment to the design, engineering and manufacturing of safe vehicles. Please make it the foundation of your personal commitment to this very important customer right.

Sincerely,

A handwritten signature in dark ink, appearing to read "G. Greenwood", written over a horizontal line.

Figure 2 - Chrysler Bill of Rights

- H. Volvo has stated that it has a goal that no one is killed or injured in a Volvo vehicle by the year 2020. Volvo has also stated that, “Technologies for meeting the goal of zero injuries and fatalities are basically known today – it is a matter of how to apply, finance, distribute and activate.” (Attachment D)
- I. Honda believes that safety is for everyone, including for other vehicle occupants and for pedestrians. This is shown below (Figure 3) in a excerpt from Honda’s website:

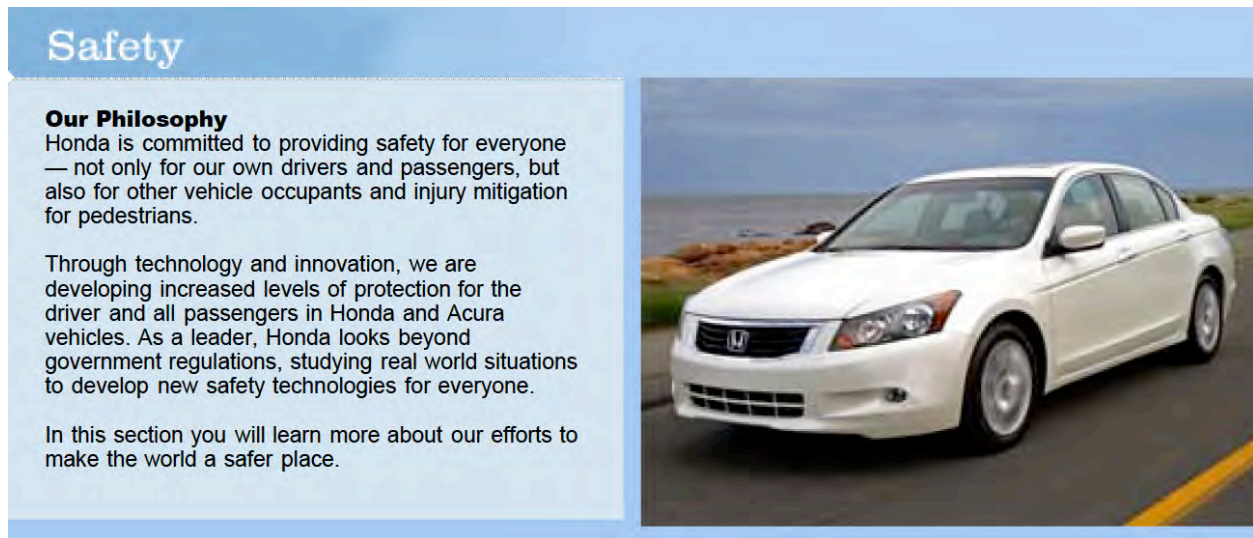


Figure 3 – Honda representation on its website

- J. Kia—which is owned by Hyundai—has specifically told consumers the following as shown below as Figure 4:

Safety when you need it most

No one can predict a collision occurring, but you can trust Mohave will protect you should the unforeseen happen. The Mohave body shell and innovative frame-type structure is designed to absorb the energy of an impact while the rigidity of the body structure and chassis gives occupants maximum protection. The extra strength of the dual dash panel contributes further to driver and passenger safety, enhanced by the advanced airbag system - including safer depowered dual front airbags that have lower pressure impact. The curtain and side airbags feature rollover sensors which anticipate and engage airbags simultaneously to cradle and protect passengers. The front seats have an active headrest option which works with the body to move forwards and upwards during a rear impact collision, thereby preventing neck and head injury.

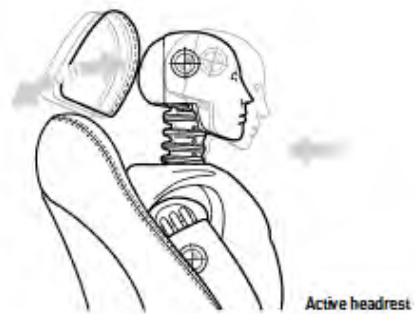


Figure 4 - Kia excerpt from Mojave brochure

- K. Given the above statements from various automakers, consumers naturally expect that their vehicle will properly protect them in the case of a foreseeable accident. Consumers expect their survival space will be maintained during an accident. Consumers also expect that the manufacturer has utilized the best, most technologically advanced design, engineering, and material to ensure protection during an accident event. Consumers expect that manufacturers have expertise in design, testing, engineering and engineering analysis. Consumers expect that the vehicles they ride in have been rigorously tested and

evaluated. Consumers expect that marketing literature is honest, truthful, and based on fact.

VI. Engineering Judgment

- A. Engineering judgment is a major part of the methodology for design, development and testing of a motor vehicle. During the design concept phase of a program, there are no physical properties to test, therefore an engineer has to rely on past experience and judgment to carry out the initial design work.
- B. When a test program is defined, it is not possible to test for every variable. So again, an engineer must use his or her judgment to define what tests to do, and on what specification of vehicle. Due to options on vehicles, it is not possible to test every option for every test. So an engineer must use judgment to select what configuration of vehicle represents the “worst case” for a particular test. This “worst case” can vary from test to test. For example, with a vehicle equipped with both a V8 and 6 cylinder engine, for a driveline durability test, the V8 version would be the worst case, and for a towing test, the 6 cylinder would be the worst case. In the case of testing for inadvertent airbag deployment the test vehicle choice depends on other variables.²
- C. If a test failure occurs, or if a danger is otherwise identified, then it is not necessary to complete every test to prove the extent of the danger. A decision is made on either a design change, or other countermeasure and testing is repeated for the dangerous condition, and testing not yet done is continued with the new condition.
- D. For example, this engineering judgment concept as applied to reclined seat dangers is the reason why extensive rollover testing with reclined seats has never been performed in the industry. The testing performed by GM and others that demonstrates the dangers of reclined seat in frontal and rear impacts is enough to establish the condition. Once a dangerous condition is established, it is not necessary to run further testing to prove other ways that seat recline is dangerous.
- E. Engineering judgment is also applied to vehicle packaging. Vehicle packaging is the science of locating all of the necessary components and systems of a vehicle in their design location and studying how they interact with each other for fit, function and performance. Vehicle packaging as it relates to crashworthiness is discussed above in this report. There are packaging principles that have been learned over time such as:
 - 1. Fuel tank location is not outside the frame rails.
 - 2. Tire clearance is checked for a range of suspension motions.
 - 3. Engine compartment clearance takes into account the movement of the engine on its mounts.
 - 4. Cargo nets are used to contain objects in the trunk area of SUV’s or minivans.

² Aboud, G. M., Repp, J. H., Sirola, C. L., Husby, H. S., “Inadvertent Air Bag Sensor Testing for Off-Road Vehicles.”

“Most important is to get the largest possible fore-aft acceleration input to the sensor during the test sequence. To accomplish this, it is best to use a base vehicle suspension, i.e., lower spring rate/light duty shocks. A base vehicle will hit full jounce faster, and the vehicle body will absorb more of the event’s energy rather than the suspension system. Another factor to consider is weight. A lighter vehicle changes velocity faster during these types of tests.”

5. Spare tires are no longer carried in the occupant compartment due to the difficulty of securing them in a collision.
6. Power window switches are no longer in an orientation that allows them to be activated accidentally by a child.

There are some packaging tasks that will continue to evolve such as:

1. Interior packaging for larger or obese occupants.
2. Video screen and infotainment systems are evolving with technology changes. This will require every new object to be evaluated for interaction with the occupant in a collision.

VII. Investigation, Materials Reviewed

- A. In performing my analysis, I began with an examination of the documents and testimonial evidence that was available regarding this particular accident. The evidence and testimony included:
 1. Official Oklahoma Traffic Collision Report and other Police file material
 2. The accident vehicle
 3. The EDR download of the subject 2012 Chevrolet Malibu
 4. Medical records
 5. Plaintiff's First Amended Petition
 6. General Motors Responses to Plaintiff's 1st Interrogatories
 7. General Motors Responses to Plaintiff's 1st Request for Production
 8. General Motors Responses to Plaintiff's 2nd Request for Production
 9. Deposition testimony:
 - i. Hamed Sadrnia
 - ii. David Prentkowski
 - iii. Elizabeth Kiihr
 10. Documents produced by General Motors.
 11. Injury biomechanics and occupant protection opinions of Dr. Mariusz Ziejewski, Ph.D.
 12. Accident reconstruction opinions of Mr. Munsell.
- B. I also performed an inspection of the subject accident vehicle.
- C. I have reviewed published literature and patents appropriate to this case.
- D. I have reviewed IIHS testing of the Chevrolet Malibu.

VIII. Accident Background

- A. According to the Official Oklahoma Traffic Collision Report:
 1. The accident occurred on March 17, 2014 at 4:04 pm at 10200 N. Spencer Jones Road near NE 63rd in Oklahoma City, Oklahoma. The speed limit is 50 mph on this road.
 2. The subject vehicle was a 2012 Chevrolet Malibu. Oklahoma license plate 835KDG, the VIN is 1G1ZDSEU0CF383419

3. Ashley Faust was the driver of the Chevrolet Malibu and K[REDACTED] F[REDACTED] was the front seat passenger of the Chevrolet Malibu. There were no other occupants of the vehicle.
4. Safety restraint use indicated that K[REDACTED] F[REDACTED] was wearing the available shoulder and lap safety belts, her frontal airbag was not deployed, she was not ejected and she had to be extricated from the vehicle.
5. The police narrative was as follows:

Unit-1 was traveling in a North East direction on Jones Spencer Road. Unit-1 driver crossed the centerline and was driving in the southwest lane. Unit-1 continued in the northeast direction right of the centerline. Unit-1 departed the roadway and collided with a tree. At this time it is not clear why the driver departed the roadway.

IX. Vehicle Inspection

- A. I inspected the Faust vehicle on December 8, 2016 in Norman, Oklahoma. My inspection resulted in the following findings:
 1. Vehicle damage findings that were significant to my investigation were as follows:
 - a. The Chevrolet Malibu has impact damage that can be characterized as a frontal offset pole impact. The damage to the vehicle structure is more pronounced on the driver side of the vehicle. The passenger side suffered little damage and intrusion. The majority of the damage to the passenger side door was due to rescue efforts utilizing the “jaw of life” equipment. Figure 5 below shows the comparative damage side to side.



Figure 5 - Comparative damage to both sides of the vehicle

- b. Only the driver side frontal airbag was deployed. The passenger side frontal airbag was not deployed.

- c. There are loading marks on the passenger side safety belt system that indicates usage.
- d. The occupant survival space is maintained relatively well for the passenger and not for the driver. Figure 6 below shows the comparative survival space for both the driver and passenger side by side.



Figure 6 - Comparative survival space between the passenger and the driver

- 2. Seat belt usage physical evidence: The subject vehicle uses a 3-point safety belt. There are load marks on the seatbelt hardware consistent with belt use. The marks on the webbing indicate that there could have been up to 9.5" of load limiter deployment.



Figure 7 - Safety belt loading marks are apparent

- B. The inspection lead to the following reasonable conclusions:
 - 1. A casual observer, without the knowledge of the airbag lack of deployment, would conclude that the driver would have been more seriously injured in this collision. However, that is not what occurred.
 - 2. The Chevrolet Malibu being driven by Ashley Faust struck a tree in a head on configuration.

3. This accident was typical of the type of event that General Motors or any other reasonable automotive manufacturer would have anticipated in the design and development of this vehicle.
4. This Chevrolet Malibu is not reasonably safe from a design standpoint and it is defective for occupant protection with a passenger whose size is nominally a 5th percentile female.
5. The vehicle violated principles of crashworthiness.

X. Analysis

A. Restraint System Analysis:

1. The restraint system is a system that includes many components, which cannot be viewed in isolation. Specifically, some of these components comprising the restraint system in the subject vehicle are: The seat with occupant classification system, airbag, safety belt system (which has further components affecting system performance), knee bolster and instrument panel.
2. Passenger side frontal airbag failure to deploy:
 - a. The passenger airbag did not deploy. Since the driver's airbag deployed it is possible to rule out any sensing issues since at least a second stage airbag deployment was commanded for the driver frontal airbag. Some reasons that the passenger airbag would not deploy are: Electrical circuit not complete or damage, defective airbag module, or a defect in the occupant classification system (sensor, module or software).
 - b. My opinion is that the passenger side frontal airbag did not deploy due to the occupant classification system miss-classifying K█████ F█████. K█████ F█████ should have been classified as a 5th percentile female by the vehicle's system, however this did not occur. Whatever classification the system erroneously used, it incorrectly suppressed the passenger side airbag.
 - c. A consumer would expect that in an accident that would deploy an airbag for an adult sized driver that it would also deploy for an adult size passenger.
 - d. Autoliv, the restraint system manufacturer for the 2012 Chevrolet Malibu is aware of the dangers of an airbag non-deployment.³⁴

³ David Prentkowski deposition, page 149

"But, if the airbag doesn't fire, it allows the head, neck and torso to move towards the dashboard and the only thing that's going to stop the head, neck and torso is the dashboard."

⁴ David Prentkowski deposition, page 153

"If there was no air bag deployment, the restraint system as an overall occupant protection device did not do what it was originally designed to do."

3. Occupant classification system defect:

- a. According to the General Motors “Static Automatic Suppression Component Technical Specification”, “The system consists of three major items, a sensor(s), and electronic module and wiring, and a connector to interconnect with other vehicle systems. (Note that this content definition does not necessarily prohibit the use of additional sensors or the outputs of existing vehicle sensors to enhance the performance of the System.)”
- b. One of the functions of the system is to “Provide an output to the SDM to allow passenger airbag deployment when the occupant of the front-outboard passenger seat is an adult (5th-percentile female or larger). Also, in section 3.2.1.1, “The system shall allow deployment of the airbag when any belted or unbelted occupant who weighs (greater than or equal to) 46.7 kg (103 lb.) and is (greater than or equal to) 139.7 cm (55 in) tall is normally seated or is in certain mispositioned orientations in the front-outboard passenger seating position.”
- c. At a doctor visit on March 10, 2014, K [REDACTED] weight was recorded as 103.62 lbs. and her height was recorded as 58.27”. This visit was one week prior to the fatal accident. This is likely the most accurate record of K [REDACTED] size at the time of the accident. This meets the qualifications to be classified as a 5th percentile female occupant.
- d. According to EMS records on the date of the accident, K [REDACTED] weight was 116 lbs. and her height was 5’5”. These numbers are likely estimates and not as accurate as the doctor records. I did not analyze any other medical records or records of K [REDACTED] height and weight.
- e. This defect in the occupant classification system was the cause of the failure of the passenger side airbag to deploy and provide the intended protection for K [REDACTED] F [REDACTED]

4. Safety belt usage:

There is ample evidence that [REDACTED] F [REDACTED] was wearing her available safety belt:

- a. The police report indicates that the safety belt restraint was used.
 - b. There are loading marks on the seatbelt hardware (D-ring, webbing and latch plate).
5. The restraint system in the 2012 Chevrolet Malibu features a 3-point safety belt with a retractor pretensioner, an anchor pretensioner, a load limiter, and a Dynamic Locking Latch Plate (DLLP). The 2012 Chevrolet Malibu was also equipped with frontal airbags, side curtain impact airbags and front seat mounted side impact airbags.
6. The restraint system in the 2012 Chevrolet Malibu was designed in a manner that requires the safety belt and the airbags to work together.⁵⁶ However, there are tests

⁵ David Prentkowski deposition, Page 85.

and performance requirements to be met when a safety belt is not worn. The FMVSS 208 has requirements for unbelted testing. There are no test or performance requirements for an airbag failing to deploy.

7. Airbags were originally intended as a “supplemental restraint system” (SRS) to passively protect those occupants that did not wear their safety belts. However, safety belt systems were subsequently re-designed to work along with airbags. However, there is no FMVSS testing or performance requirements for the situation where an airbag does not deploy. General Motors does not test their vehicles for performance when an airbag does not deploy. There are feasible designs to adapt a safety belt for the condition when an airbag does not deploy. When a manufacturer is designing a system to intentionally suppress an airbag they should consider that an error could result in the airbag being suppressed when it is not intended to.
8. Safety Belt Load limiters were first patented in the mid to late 1960’s in an attempt to reduce belt related injuries in motor vehicle crashes. In the 1990’s vehicle manufacturers “rediscovered” force limiters and found that they could be useful in improving their scores in Government New Car Assessment Program (NCAP) crash tests. Unfortunately the manufacturers were willing to give up some real world safety for improved scores in the tests. Currently, auto manufacturers have many vehicles in production that severely compromise occupant safety by introducing safety belt webbing slack, through the use of a force limiter, which either allows excessive occupant motion and or contact with interior components, such as the instrument panel of the vehicle, or they allow this slack to contribute to partial or full ejection of the occupant during multiple impact or rollover type accidents.
 - a. Proper application of a force limiter system within a safety belt requires a fairly high force to start the system and a system to then take up that slack between impacts so as not to compromise the overall safety of the system in multiple impact and rollover scenarios. This would be a more state of the art application, for example, and electric pretensioner could be designed to take up slack between impacts, however I am not aware of any manufacturer currently using load limiters in this fashion.
 - b. The dangers of load limiters include excessive excursion, which can result in contact with the interior components. Excessive belt slack can also cause the safety belt to slip off the iliac crest.
 - c. The risk of using a load limiter with a force level lower than 6 kN was known. If a load limiter with a low force limit was used then the airbag restraint has to be specifically designed.⁷ This specific design has to consider the load sharing

““I believe that General Motors would know that air bags and seat belts are designed to work together, and if one of those components doesn’t do what it was designed to do, you’re going to have less-than-optimum restraint.”

⁶ David Prentkowski deposition, page 161.

“From a system performance standpoint at the vehicle level, they are designed to work together.”

⁷ Foret-Bruno, et. al. “Thoracic Injury risk in frontal car crashes with occupant restrained with belt load limiter.” Society of Automotive Engineers paper number 983166 page 13.

between the airbag and the safety belt. The lower the load limiter value the more important it is to have airbag deployment.⁸

- d. In order for safety belts with load limiters to meet legislative requirements Federal Motor Vehicle Safety Standard 209 required a major revision to the standard. FMVSS 209 contains a requirement for belt webbing elongation and that requirement was waived if the safety belt were equipped with a load limiter and the vehicle installation required an airbag.
- e. The Insurance Institute for Highway Safety has studied the effect of load limiters. Even in situations where the air bag does deploy they identified dangers with load limiters.⁹ The IIHS further identified that load limiters had resulted in head contact with the steering wheel, even in the presence of a deployed airbag, in 52% of their tests. Of the vehicles they have tested without load limiters and deployed airbags there was head contact with the steering wheel in 20% of the cases. This study encompassed 123 passenger cars testing in the moderate offset frontal deformable barrier test mode.
- f. It is my opinion that the goal of lowering the force level of load limiting safety belts is to achieve a better rating in the NHTSA NCAP test.¹⁰ While chest injuries are the most common injury area related to fatality in a frontal impact, the use of lower safety belt force has not been proven in the real world.¹¹ The 2008 Chevrolet Malibu has a 5 star rating for both the driver and the passenger. The National Highway Traffic Safety Administration (NHTSA) introduced a new rating system for 2011. The 2011 Chevrolet Malibu was awarded a 4 star rating under the new, more rigorous rating system.

“Such, a restraint system has to include a specifically design airbag which as to absorb a significant part of restraint energy.”

⁸ Kitigawa, Y., Yasuki, T., “Correlation among Seatbelt Load, Chest Deflection, Rib Fracture and Internal Organ Strain in Frontal Collisions with Human Body Finite Element Models.” IRCOB Conference 2013, Page 292.

“Assuming an equivalent forward motion of the chest, the load limiter value mostly changes the ratio of load sharing between the seatbelt and the airbag.”

⁹ Brumbelow, M., L., Baker, B., C., Nolan, J., M., “Effects of seat belt load limiters on driver fatalities in frontal crashes of passenger cars.” Page 10

“Changes in driver fatality rates associated with the installation of load-limiting belts in passenger cars suggest this restraint technology has not reduced and may have increased the risk of driver fatality in some crashes.”

¹⁰ Brumbelow, M., L., Baker, B., C., Nolan, J., M., “Effects of seat belt load limiters on driver fatalities in frontal crashes of passenger cars.” Page 2

“Load limiters have improved test scores for many vehicles in NHTSA’s New Car Assessment Program (NCAP), and this may have increased the use of such devices as manufacturers tried to achieve better NCAP ratings.”

¹¹ Kitigawa, Y., Yasuki, T., “Correlation among Seatbelt Load, Chest Deflection, Rib Fracture and Internal Organ Strain in Frontal Collisions with Human Body Finite Element Models.” IRCOB Conference 2013, Page 282.

“Actual Benefit of lower the seatbelt load in a state-of-the-art restraint system is not well understood.”

9. Additional safety belt features are pretensioners. Pretensioners are intended to take any slack out of the system in the event of a collision. There are different strategies in use by automotive manufacturers. They can be deployed simultaneous to airbag deployment or they can be deployed prior to airbag deployment. The subject 2012 Chevrolet Malibu was equipped with two pretensioners. One in the retractor and one at the safety belt anchor. The EDR download indicates passenger pretensioner deployment. Visual inspection indicates that the anchor pretensioner has deployed. However, at the time of this report, I have not inspected the retractor pretensioner nor have I seen specifications as to the deployment strategy.

B. Accident Analysis

1. EDR analysis:
 - a. The vehicle speed one second prior to the event was 53 mph.
 - b. The vehicle decelerated from 66 mph to 53 mph in the time between two seconds prior to the event and one second prior to the event. This is a deceleration rate of 0.6 g's.
 - c. Steering angle 1 second prior to event was 224 degrees towards the right (positive value)
 - d. Yaw rate is 14 degrees/second at 1 second prior to event.
 - e. The passenger airbag was suppressed at algorithm enable and at First Deployment Command.
 - f. The delta V was recorded as 65.74 mph.
2. I have directed and analyzed vehicle crash tests and sled tests for numerous automotive manufacturers. I have also analyzed thousands of crash tests conducted by NHTSA contractors, the IIHS, and many automotive manufacturers. I have inspected hundreds of vehicles that have been involved in real world collisions. I have directed many vehicle dynamics simulations, including conducting my own simulations as far back as my education at GMI, and I have performed hundreds of vehicle dynamics tests.
3. With all of my education, training, knowledge, skill and experience, I have evaluated the subject Faust collision from an overall reconstruction standpoint as it relates to survivability and injury absent a vehicle defect. This is a survivable accident from a crashworthiness engineering standpoint for the front seat passenger. Or, rather, it should have been survivable for K [REDACTED] F [REDACTED]
4. The driver and passenger experienced the same collision; however, the difference is that the restraint system performed as it was designed to on the driver side and not on the passenger side.

C. Review of documents produced by General Motors:

1. General Motors provided the specification for "Static Automatic Suppression Component Technical Specification."
 - a. 3.2.1.1 "Mispositioned orientations include the occupant on the vehicle seat (1) rotated up to 30 degrees CW, (2) rotated up to 30 degrees CCW, (3)

mover inboard up to contact with the passenger's inboard seat-belt-buckle, (4) mover outboard up to contact with the passenger door, and (5) sitting on a blanket up to 1-inch thick"

- b. The 2012 Chevrolet Malibu *does not* comply with this General Motors Technical Specification.¹² The 2012 Chevrolet Malibu only complies with the minimum FMVSS standard and not General Motors own specification.

2. Safety belt system changes

- a. The GMX368 was manufactured for the 2008 through 2012 model years. During this production run there were numerous changes to the safety belt system.
- b. The following is a chart (Figure 8) that shows the changes to the load limiter force throughout the design and manufacturing cycle of the GMX386 Chevrolet Malibu.

	2008	2008 SORP	2011	2011 running change
Driver load limiter static rating	3-4 kN	5 kN	2.5 kN	
Passenger load limiter static rating	3-4 kN	5 kN	2.5 kN	2.0 kN
Note: The 2008 used a digressive force feature				
Note: SORP is Start-of-regular-production				

Figure 8 - Malibu Load limiter chronology chart

- c. A recent study has shown there is no reason to use a load limiter force as low as 2 kN and that reductions of force lower than 4 kN may not provide any benefits for injury reduction.¹³

D. Safer alternative designs:

1. Safety belt alternative designs:

- a. Load limiters with a stop: Load limiters with a stop are designed to only allow a certain amount of belt slack into the system. One design is to allow one or less

¹² Deposition of Elizabeth Kiihr, page 106.

¹³ Kitigawa, Y., Yasuki, T., "Correlation among Seatbelt Load, Chest Deflection, Rib Fracture and Internal Organ Strain in Frontal Collisions with Human Body Finite Element Models." IRCOB Conference 2013, Page 293.

"The simulation results indicated that lowering the load limiter value, for instance from 4 kN to 2 kN, did not necessarily reduce the chest deflection."

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"The first finding in this study was that a lower load limiter value did not necessarily give the smallest chest deflection."

rotation of the retractor spool. This relates to approximately 6 inches of belt slack. Load limiters with a stop have been used on production vehicles since the 1990's and are currently in use on current model vehicles. Current applications include many vehicles in Europe for rear seat applications and certain General Motors vehicles since 2010. Since the addition of a rear seat crash test dummy for the Euro NCAP test, vehicles with load limiting safety belts in the rear seat have added a stop feature.

- b. An adaptive load limiter could have been used. This design is considered for applications where an airbag is not used.¹⁴ As applied to the ability to provide performance when an airbag does not deploy, the adaptive load limiter would only operate in the low load limit range once airbag deployment is commanded.
 - c. General Motors could have used a higher force on the load limiter, which they did for the 2008-2010 Malibu, which had a load limiter force of 5 kN.
2. Seat design: A better alternative design would be one as outlined in a design that was patented by Hyundai (US Patent 7730794). This patent eliminates the need for a mat on the seat cushion and instead uses load sensors on the seat frame. Figure 9 is a drawing from the patent showing the location of the sensors.

¹⁴ Clute, G., Autoliv, "Potentials of adaptive load limitation presentation and system validation of the adaptive load limiter." Page 1

"For the case of wanting to have a Homologation of the belt system without airbags in accordance with the regulation ECE-R16, the adaptive load limiter requires a pre-set condition with the high load limitation level active."

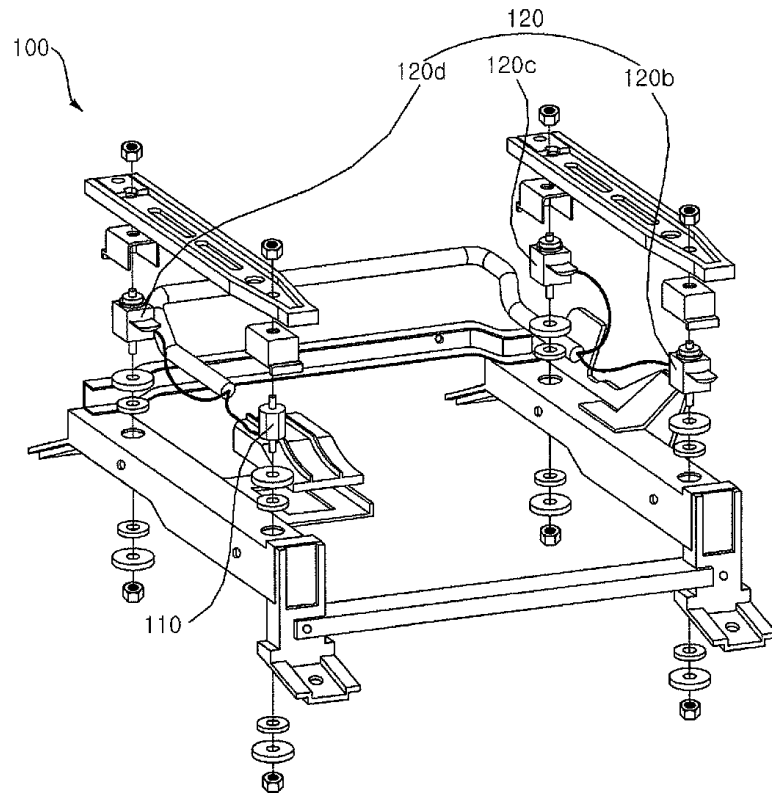


Figure 9 – Hyundai patent drawing

3. Occupant Classification System: General Motors would have been aware that there were better systems in existence for use in an OCS. Hyundai has patented an alternative design that uses load sensors on the seat in a manner that cannot cause interference with the seat cushion or affect anti-submarining effectiveness. Other automotive companies such as Ford have used this design.
4. Technological and economical feasibility: The proposed safer alternative designs were both technologically and economically feasible. Further, the proposed safer alternative designs would not have materially affected the utility of the vehicle. Instead, these designs would have permitted the vehicle to have utility. Any vehicle that does not provide adequate frontal impact protection has no utility.
5. The safer alternative designs would have prevented the fatal injuries to K█████ F█████.
6. The safer alternative designs have been crash tested by vehicle manufacturers, the NHTSA, other testing agencies and research facilities and each of these proposed designs would have prevented the fatal injury by either ensuring that the airbag does deploy, or by providing a system that performs the restraint function in the absence of a deployed airbag.

7. All of these alternative designs and claims of improvement are technologically and economically feasible since they have been used on production vehicles. These safer alternative designs would have prevented the fatal injuries to ■■■ F■■■ without materially affecting the utility or functionality of the vehicle.
8. All of the restraint system defects discussed in this report could have been eliminated by safer alternative designs that would not affect the utility of the restraint system. Various vehicle manufacturers have utilized each of these alternative designs because they are technologically and economically feasible. Each of these safer alternative designs have been tested and proven to prevent injuries including the type of fatal injuries suffered by K■■■ F■■■.

E. Performance relative to the General Crashworthiness Principles:

1. Applying crashworthiness principles, K■■■ F■■■ would likely not have had fatal injuries had the 2012 Chevrolet Malibu she was riding in been equipped with a properly designed restraint system. The following outlines how the subject 2012 Chevrolet Malibu vehicle performed relative to the principles of crashworthiness.
 - a. The vehicle's survival space was well maintained in the area in which K■■■ F■■■ was seated. The structural integrity was maintained on the passenger side of the subject vehicle.
 - b. The safety restraint system failed to provide proper restraint. The safety restraint system includes the passenger side frontal airbag that failed to deploy in the type of accident that it would be expected to.
 - c. Because of the failures of the vehicle restraint system, K■■■ F■■■ suffered fatal injury.
 - d. The vehicle did not experience a post-collision fire.
2. The Safety Restraint System, violated the above principles of crashworthiness, particularly in the area of providing proper restraint.
3. The Safety Restraint System failure violates the basic principles of crashworthiness because it renders the other aspects of crashworthiness ineffective.
4. The analysis of a collision where a safety belt system or an airbag restraint fails is primarily a crashworthiness evaluation.
5. A safety belt system or an airbag system are crashworthiness safety systems since neither one is designed to prevent accidents. In fact, no crashworthiness design principle will prevent accidents.
6. The purpose of a Safety Restraint Systems is to minimize injuries and deaths following a collision by providing proper restraint throughout the entire accident.
7. The purpose of a safety belt is to minimize injuries and deaths following a collision by providing proper restraint throughout the entire accident. Proper restraint is defined as:
 - a) Applying loads to the strong parts of the body.
 - b) Minimizing injurious and fatal contacts inside the vehicle.

c) Preventing ejection

8. The subject 2012 Chevrolet Malibu failed to provide proper restraint by failing to deploy the passenger side frontal airbag.

XI. Anticipated Defenses

A. General Motors will likely state that the cause of the accident and the fatal injury to K█████ F█████ was the driving of her mother, Ms. Ashley Faust who failed to stay in her lane of travel and departed the roadway. While it is true that Ms. Ashley Faust's failure to stay in her lane was the cause of the accident, the accident did not cause the fatal injuries to K█████ F█████. It was the defective restraint system design of the 2012 Chevrolet Malibu that was the cause of her fatal injury. All of the major automotive companies and suppliers are aware that accidents will occur involving the vehicles that they have designed, developed and manufactured. They also understand that the vehicle has no way of determining "fault". The vehicle must protect the occupants regardless of who was at "fault" in the accident. In fact, it is the responsibility of manufacturers to even protect individuals who *are* at fault in causing an accident.

1. Ford employee and corporate representative Roger Burnett stated the following in a deposition in the *Diederich v Ford* case:

Page 9

1 next step, designing a vehicle.

2 Q. And you'd agree that those that are in the Ford
3 vehicles, the occupants of the Ford vehicles deserve
4 this protection, this safety that Ford offers
5 regardless of who make -- who may make a mistake and
6 cause an accident?

7 A. Well, if you're talking about the crash performance,
8 technically it doesn't really matter how the car got
9 in the crash, there's other aspects of vehicle safety
10 that might -- that are more integral to the occupant
11 and how the occupant controls the vehicle. But once
12 you're in a crash, then you sort of switched over to
13 the crash performance of the vehicle. Say you're
14 driving into a tree, at that point the car doesn't
15 care how you got there, you're going to crash into
16 that tree. They don't care if you're there because
17 you are speeding or you're drunk or someone bumped you
18 off the road.

19 Q. I appreciate. That wasn't quite my question. What
20 I'm asking, though, is that Ford would agree that it
21 doesn't matter who causes an accident, who drives into
22 the tree, there's people in the occupant -- there's
23 occupants in the vehicle who still deserve the safety
24 of the protective devices Ford offers?

25 MR. SOUTHERLAND: Object to form.

1 A. What I was trying to do is differentiate for you the
2 pre-crash safety where it does matter and the point
3 where you're hitting the tree, it doesn't matter.
4 It's just at that point, it doesn't matter how you got
5 there.

6 BY MR. MATTHEWS:

7 Q. So what you're saying then and let's first off, let's
8 get where we agree is at the point of hitting the
9 tree, at the point of the crash sequence, it doesn't
10 matter why the crash happened, all that matters is
11 that those safety devices work as designed and protect
12 the people as best they can?

13 A. That's right.

2. General Motors employee Dr. Derek Guo has stated the following in a deposition in the *Hillard v General Motors* case:

16 A. Right, yeah. It's a safety feature.
17 Q. Do you agree that a vehicle's safety systems,
18 they have to perform regardless of who caused the
19 accident?
20 A. Yeah. I mean, it will -- I mean, the good
21 designs, those features, those functions, they
22 work, and -- during the crash.
23 Q. And it doesn't matter --
24 A. It's designed, right.
25 Q. And it doesn't matter who caused the accident.

Derek Guo, Ph.D.
March 30, 2017

17

1 Those safety --
2 A. A crash is a crash, yes.
3 Q. A crash is a crash, and the safety systems have
4 to perform no matter who causes the accident;
5 correct, sir?
6 A. Right. Yeah, really it's irrelevant of who cause
7 it. It's more what kind of condition the crash
8 was in.

- B. The cause of K█████ F█████ fatal injury was not the accident, but the failure of the 2012 Chevrolet Malibu to adequately protect her during the accident. The defective restraint system that allowed excessive intrusion into the occupant compartment was the cause of K█████ F█████ fatal injury. It was technologically and economically feasible to provide a restraint system capable of providing this protection. Crashworthiness safety systems do not prevent accidents from happening; they prevent and minimize serious and fatal injuries.
- C. To suggest that the accident is the sole cause of K█████ F█████ fatal injury is an affront to decades of vehicle crashworthiness development. Further, engineering design principle 101 dictates that engineers must design for foreseeable use and foreseeable misuse and that safety should be of paramount importance.
- D. General Motors may claim that this type of accident is a rare event. General Motors is aware of the risk of this type of accident. The following chart (Figure 10) shows that “Off-roadway” is a type of accident that, while not occurring as often as the other modes, it is the accident mode that results in the highest percentage of fatalities.

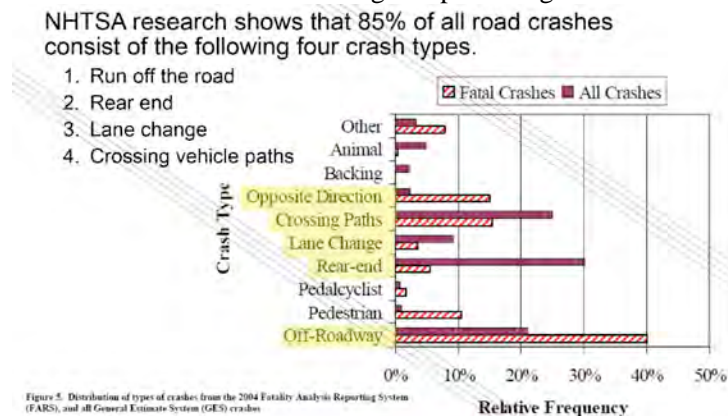


Figure 10 – NHTSA research on accident types, circa 2004

- E. General Motors may claim that K█████ F█████ was seated improperly and that she was too young to be seated in the front seat. As far as K█████ being too young to sit in the front seat, the important parameter at the relevant age for K█████ is the size of the person. There are no developmental issues at age 11 that would prevent her from sitting in the front seat as a 5th percentile female. As far as General Motors making a claim that K█████ was improperly seated then I would refer to the fact that General Motors *did not* meet their own standards for an out-of-position occupant.
- F. General Motors may claim that this accident was too severe to survive. While the collision was severe, it should not have caused a fatality. The driver of the vehicle, Ashley Faust, did survive the collision with the tree with certain injuries. These included; facial fractures, lose of her right eye, jaw fracture, dislocated wrist, vertebrae injury, open fracture of right knee, fractured kneecap and dislocation or break of right ankle. The driver position suffered more intrusion than the passenger side, and approximately the same deceleration forces. It could be reasoned that the accident was more severe for the driver due to the intrusion but the vehicle deceleration was similar for both. However, with a deployed airbag the driver survived the collision, while K█████, without the benefit of her airbag did not survive. The simple conclusion is that K█████'s death was

due to the fact that she was denied her airbag in a collision that the vehicle design was intended to provide an airbag for. It was not the severity of the collision that caused the fatal injury to K█████ F█████ it was the failure of the restraint system to deploy the passenger side frontal airbag that caused her fatal injury.

XII. Compliance with FMVSS:

- A. Defendant may take the position that it complied with all applicable FMVSS provisions. The FMVSS provisions are minimum standards. They do not cover many parts of the human body that need to be protected. These same FMVSS provisions do not adequately evaluate the protection capabilities of vehicles. Indeed, Joan Claybrook, former administrator of the NHTSA wrote a letter to major auto makers where she said, “Our federal safety standards are and were intended by Congress to be minimum standards. The tragedy is that many manufacturers have treated the standards more like ceilings on safety performance rather than floors from which to improve safety.”
- B. As such, FMVSS provisions are inadequate to protect the public from harm. For example, FMVSS 206 has no dynamic provision to evaluate door latch strength. FMVSS 207 fails to consider the weight of an occupant acting on the seat in a rear impact collision. FMVSS 208 fails to require dynamic testing of the safety belt restraints provided for occupants in the rear seats. FMVSS 213 fails to evaluate child seats in side, rollover or multiple impact events.
- C. FMVSS 214 uses a side impact barrier that is not configured like the many of the vehicles on the road. FMVSS 214 does not consider a collision to the passenger side of a vehicle. The FMVSS 214 tests are all to the driver side of the vehicle with only driver side occupants required.
- D. FMVSS 216 evaluates roof strength over 120 seconds on only one part of the roof in a quasi-static manner without any consideration to roof contact with the occupant (no crash test dummy is used during this test). This is in contrast to a rollover crash, which has real people and sudden impacts with multiple parts of the roof.
- E. The introduction of FMVSS 216a (published April 2009) does add the features of consideration for occupant and it increase the minimum load that needs to be sustained from 1.5 times the vehicle weight to 3 times the vehicle weight. It is apparent that manufacturers are now designing cars to meet this requirement without any technical issues, merely a decision to achieve a higher goal.
- F. In spite of the Federal regulations requiring a doubling of the roof strength, the Insurance Institute for Highway Safety (IIHS) has set their rating to require a strength to weight ratio (SWR) of 4 times vehicle weight in order to achieve a “good” rating. It appears that many manufacturers are setting this as a target.
- G. Auto Manufacturers routinely lobby for minimizing the Federal Motor Vehicle Safety Standards with the argument that marketplace pressures, customer satisfaction, and ultimately, litigation will be factors, which will cause them to manufacture safe vehicles.
- H. Recalls are another mechanism for public safety. There are millions of vehicles involved in recalls each year. The vast majority of these recalls are not for vehicles that did not comply with Federal regulations, but for vehicles that have a product defective even

though they do comply with Federal regulations. Complying with, and even exceeding all Federal legislative regulations does not ensure that a vehicle is free of defects.

- I. House Energy and Commerce Committee report questions NHTSA: In September of 2014 a Congressional report was issued in response to the General Motors ignition switch recall. The report questioned whether NHTSA has the technical expertise, culture and analytic tools need to address safety issues. The report stated, “NHTSA also lacked the focus and rigor expected of a federal safety regulator”. It was also stated that NHTSA staff has a “lack of knowledge and awareness regarding the evolution of vehicle safety systems they regulate.” And that “Vehicle technology is advancing rapidly and NHTSA must be willing, and able, to keep pace.”

XIII. Identification of Risks, Hazards and Dangers

- A. A safety engineer's primary responsibility is to identify potential risks hazards and dangers associated with reasonably foreseeable uses and misuses of a product. Then, he should attempt to design out the dangers, guard against them or, as a last resort, warn about them.
- B. Frontal impact accidents are highly foreseeable events.
- C. Engineers must conduct engineering analysis to identify potential risks, hazards and dangers so that the risks, hazards and dangers can be designed away, guarded against or warned about.¹⁵ Only if the first two principles are not available should a warning ever be needed.
- D. General Motors engineers and managers should have used one of the many available techniques to analyze the safety of the 2012 Chevrolet Malibu vehicle restraint system in a frontal impact scenario to the vehicle.
- E. Some of these engineering techniques include DFMA (Design Failure Mode Effects Analysis), FMEA (Failure Mode and Effects Analysis), FEA, fault tree analysis, root cause analysis, and risk hazard analysis.
- F. I have seen no engineering triad analysis, fault tree analysis, DFMA, root cause analysis or by whatever name called that was conducted by General Motors. This omission is important because this is the primary role and responsibility of an engineer.
- G. The lack of engineering analysis and poor decisions about frontal impact lead to a defective vehicle being introduced into the stream of commerce. General Motors was aware of the danger of foreseeable frontal impact accidents, however they were negligent in their decision making for performance testing for frontal impact accidents.

¹⁵ National Safety Council, Product Safety Management Guidelines, second edition. 1997, p. 36

“The first concept is the safety engineering hierarchy of priorities:

- 1) *Eliminate Hazards*
- 2) *When hazards cannot be eliminated, provide feasible safeguards against them.*
- 3) *Provide warnings and personal protective equipment against remaining hazards.”*

- H. General Motors was negligent for not conducting proper engineering analysis, target setting, and testing.

XIV. Conclusions

Based upon my knowledge, skill, experience, training, education, review of all the material produced in this case, analysis of the facts of this case, analysis of technical materials obtained and/or reviewed over several decades and my own engineering judgment, the following conclusions are reached to a reasonable degree of automotive engineering and crashworthiness probability:

- A. K [REDACTED] F [REDACTED] was properly wearing her safety belt at the time of this accident.
- B. The 2012 Chevrolet Malibu that K [REDACTED] F [REDACTED] was driving failed to protect her in this foreseeable accident.
- C. The restraint system on the subject vehicle is defective and unreasonably dangerous and was the producing cause of K [REDACTED] F [REDACTED] fatal injury. Had the airbag deployed as the design of the 2012 Chevrolet Malibu intended, then K [REDACTED] would not have been killed in this collision.
- D. Safer alternative design practices existed at the time of the design of the 2012 Chevrolet Malibu and were both economically and technologically feasible. These safer alternatives include different methods of classifying occupants, use of load limiter features that would operate as a fail-safe in the event of airbag non-deployment, use of a load limiter with a stop, or a higher force load limiter.
- E. The use of many of these alternative designs would not increase the risk of danger to drivers or passengers in frontal collisions, nor should that use increase the risk of danger in other types of collisions, such as side impacts, rear impacts and rollovers.
- F. The risks of serious injury or death in frontal impacts have been known for decades, yet General Motors failed to take the necessary design and engineering steps to provide an adequate restraint system in this vehicle.
- G. The vehicle's design and occupant restraint system performance violated consumer expectations and principles of crashworthiness.

Note: This report is preliminary and is subject to amendment and supplementation pending a review of further documents that may be produced by the defendant in this matter, and a review of reports by defense experts in this matter.

Sincerely,



Neil Hannemann

Attachments:

- A. Neil Hannemann curriculum vita
- B. Neil Hannemann list of testimony for the previous four years
- C. Billing schedule
- D. US Patent list for Occupant Classification Systems
- E. Safety belt reference material
- F. Airbag reference material
- G. Volvo Vision 2020
- H. IIHS information
- I. Section IV and V reference material

Additional Reference Material Reviewed:

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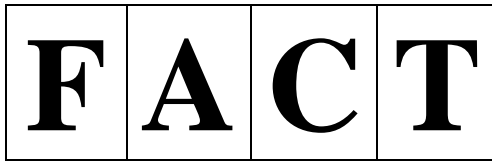
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Neil E. Hannemann
As of April 1, 2018

PRIOR TECHNICAL AREAS OF ANALYSIS:

Airbag and Restraint Systems	Advanced Driver Assist Systems	
Braking Systems/ABS	Crashworthiness	Defects Investigation
Drivetrain	Driving Expertise	Electric Vehicles
Exhaust System Design and Development		Hybrid Vehicles
Seat Design and Analysis	Smart key systems	Steering Systems
Suspension Systems	Sudden Unintended Acceleration	Vehicle Dynamics/ESC
Vehicle Components	Vehicle Design	Vehicle Fires
Vehicle Rollover	Vehicle Structures	Warnings
Wheel & Tire Design and Development		

EDUCATION:

General Motors Institute - Bachelor of Science - Mechanical Engineering - Automotive option
(1981)

PROFESSIONAL EXPERIENCE:

FACT Jan. 1, 2011 - Present
Activities included: Forensic analysis of accident vehicles and accident scenes. Consulting with, and testifying in deposition and trial for attorneys, and government agencies regarding complex automotive litigations. Testing and directing of testing, along with result analysis, of various vehicle components and systems. Testing of vehicle handling and dynamics.

AUTOMOTIVE CONSULTANT Feb.2007 – Dec. 2010
Activities included: Forensic consulting with and testifying for plaintiff attorneys regarding automotive litigations. Competition Director for the SCCA World Challenge race series. Program Manager for Kepler Motors. Race driver training and coaching, race vehicle engineering, Low volume and “niche” vehicle design, development, analysis and testing and Automotive X-prize proposal development. Consulting for Lockheed in successful defence of a government bid protest.

APTERA MOTORS, INC – Carlsbad, California March 2008 – Dec. 2008
Senior Vice President – Manufacturing and Program Management: Responsible for all aspects of product development for Aptera Motors Inc. Major focus is to develop an innovative 3-wheeled electric and hybrid/electric vehicles for consumer use.

MCLAREN AUTOMOTIVE – Woking, England March 2004 – Jan 2007
Executive Director of Engineering: Responsible for all aspects of engineering and technical integrity for current and future products. Major focus was to be a new mid-engine sports car for Mercedes-Benz. Other programs included new FMVSS 208 compliance (advanced airbag system) for the Mercedes-McLaren SLR and other future variants of the SLR. Also involved in presenting proposals for funding of the mid engine program as a McLaren branded vehicle.

FORD MOTOR COMPANY – Dearborn, Michigan Jan 2002 – Feb 2004
Chief Engineer: Responsible for Engineering, Design and Development of the new Ford GT. Directed all program planning, supplier selection criteria and organisation of an engineering team of 140 people. Implemented many concepts new to Ford for low volume “niche” vehicle development with timing compressed in an unprecedented manner for typical Ford programs, which was the key enabler for accomplishing the program. Directed extensive use of all available computer simulation programs.

SALEEN, INC – Irvine, California Oct 2000 – Jan 2002
Chief Engineer: Responsible for all Saleen engineering activity including Mustang development, aftermarket parts, and Motor sports. Primary responsibility for the overall program to design, develop and produce the Saleen S7, the latest American Supercar. Implemented a Unigraphics V17 CAD network. Directed design and development of the engine package for the S281E, utilizing an innovative supercharger.

DAIMLERCHRYSLER CORPORATION – Auburn Hills, Michigan 1989 – 2000
NASCAR Winston Cup Program Manager: Assembled and directed an Engineering team that was responsible for the aerodynamic development of the NASCAR Winston Cup Dodge Intrepid, including the design and manufacture of stamped steel race car body panels, fibreglass front and rear fascia's and Lexan windshields. Coordinated all technical support for the Chrysler Le Mans sports Car program, both with Reynard and Dallara. Directed CFD aerodynamics simulation for both the Winston Cup and Le Mans programs.

Viper GTS-R Program Manager: Recruited and developed the engineering team, selecting suppliers, and directing assistance from other Chrysler departments (Aero, structures, fabrication shops etc.). Selected race teams beginning with the 1996 race season and responsible for most aspects of the race teams. Directed a test team and two engine development companies. This program resulting in 3 LeMans 24 hour wins, 2 FIA Championships, 2 ALMS Championships and an overall win at the Daytona 24-hour race.

Aero- Thermal Development Supervisor: Directed engineers responsible for the aero-thermal development of all Large Car Platform vehicles, which included wind tunnel and environmental tunnel testing and on-road verification testing.

Suspension Design Supervisor: Responsible for the design and development of an entirely new suspension for a future model vehicle with the constraint of accommodating an AWD system with an existing FWD under body platform, resulting in a unique Dedion twist axle rear suspension concept. Responsible for developing a new system level DFMEA for Suspension Systems. Staffed a new design group of 11 engineers. Explored alternate material concepts

including aluminium. Directed detailed FEA work on the aluminium concepts to address fatigue life concerns, and dynamic structural analysis of the body attachments. Directed vehicle dynamics simulation work using ADAMS.

Vehicle Development Specialist: Responsible for the total vehicle design and development program for a future model vehicle. Lead a small advances planning group, and as the program grew past the advanced stage, I took the design work for all chassis systems.

Product Development Engineer: Responsible for vehicle development of the Viper Platform. Primary responsibility is vehicle dynamics analysis and testing, data acquisition and analysis for all chassis items, including tire testing, aerodynamics development, brakes and suspension. Specific development items have included: Engine oil system development, 3/8 scale model and full scale aerodynamic development for the Viper GTS, developed instrumentation and techniques to correlate wind tunnel data to on – road measurements, shock absorber valving, bias tuning of rear differentials.

CHRYSLER CORPORATION – Santa Fe Springs California 1982 -1989

Product Development Engineer: Located at the Chrysler/Shelby Performance Center at Santa Fe Springs California. Responsible for research and development projects directed by Carroll Shelby as feasibility studies for future Chrysler production vehicles. Directed vehicle testing, including performing all high performance driving, vehicle dynamics analysis, installation of test equipment, and analysis of data. Supervised fabrication and construction of projects and test vehicles. Developed all-wheel drive systems, limited slip differential and a rear disc brake system. Involved in the development of the Chrysler Turbo II engine. Involved in the development of two different turbo 16 valve engine programs. Involved in the initial design phase of the Shelby Can-Am racecar.

MCR TECHNOLOGY (Formerly MiniCars Inc.) – Santa Barbara, CA 1981 - 1982

Staff Engineer: Responsible for government safety research projects. Involved in conducting full-scale vehicle crash test and sled tests. Directed vehicle impact tests into highway crash attenuating devices. Directed sled testing to evaluate steering wheel and column safety performance. Involved in a program to develop an airbag landing system for a military target drone.

GENERAL MOTORS – Van Nuys, California 1976 – 1981

General Motors Institute Co-op Student: student project included: Development of the Pontiac 301 cu. in. V8 turbo engine for the 1980 Indy pace car, and validation of a cylinder head swirl flow meter at the General Motors Research Laboratory, Fluid Dynamics Department.

Activities and Accomplishments:

- Speaker at SAE Chapter meetings in Los Angeles, San Francisco, and Detroit.
- Current or past member of SAE, NASCAR, SCCA, IMSA/Sports Car
- Design Judge for Formula SAE competition in 1993, 1994, 2003 and 2007
- Selected as Car Craft Magazine “Hi-Riser” in December 1985
- Speaker at many Viper Owners clubs, GMI alumni and student groups, and many auto race fan clubs.
- Instructor and co-author of the vehicle dynamics section for DaimlerChrysler’s “Vehicle Synthesis Awareness” workshop.
- Keynote Speaker at the 2005 LS Dyna users conference in Birmingham, U.K.

- Speaker at the ImechE conference on Niche Vehicle Development Technology, September 2006.
- Guest Lecturer on Vehicle Dynamics, University of North Dakota, Fargo, April 24, 2017

Motorsports Achievements: (most done on a part time basis in addition to my Chrysler job)

- Executive Team Manager of the ViperSpeed race team which won the 1999 SCCA Speed GT Drivers Championship with Bobby Archer.
- Co-founder of the ViperSpeed race team in 1998
- SCCA World Challenge Driver Champion in 1992, 1994 and 1995 driving an Eagle Talon for Archer Motorsports
- SCCA National Endurance Driver Champion in 1985 driving a Dodge Shelby Charger for team Shelby.
- Engineering consultant for Full Time racing (IMSA GTU), Archer Brothers (Trans Am and World Challenge), and Joe Varde racing (IMSA RS).
- Lead the design and development for racing versions of the Chrysler front wheel drive transaxle. Personally built all the race transaxles used by Joe Varde in IMSA GTU competition.
- Performed engine power development for many race programs. Performed calibration changes for torque management via control of turbocharger boost level.
- Formed and directed Shelby Motorsports in 1987. Shelby Motorsports ran 2 Shelby CSX's in the IMSA International sedan series.
- Endurance co-drivers have included: Jerry Nadeau, Bryan Herta, Dorsey Schroeder, Bobby and Tommy Archer, Bill Saunders, R.K. Smith and John Paul Jr.
- Other racing experience in NASPORT, Ice racing. I have raced in the Daytona 24-hour race 5 times. I have raced at Bathurst in Australia.
- Chrysler representative to the FIA in 1996 and 1997. Saleen representative to the FIA in 2001.

Publications and Presentations:

- SAE paper, "The Role of Vehicle Control Expertise in the Vehicle Development Process"
- SAE paper, "A Study of Steering Assemblies for Evaluation and Rating of Safety Performance".
- Viper Quarterly Magazine, "Vipers racing at Bathurst".
- Ghostwriter for Olivier Berettas' "Lap of LeMans in a Viper" for the LeMans Program publication, 1997.
- "A Study of Steering Assemblies for Evaluation, Rating and Improvements of Safety Performance" DOT HS 806 665; Final Report; Minicars; N. Hannemann, S. Syson; June 1982.
- "Design and Development of a Modified Production Vehicle for Enhanced Crashworthiness and Fuel Economy" Phase I Final report; DTHN22-81-C-07085; N. Hannemann; R. Schwarz; D. Struble; S. Syson; G. Wallace; S. Forest; October, 1982
- "Driving Expertise in the Vehicle Development Process", September 2006, ImechE.

Patents:

- US 8,276,693 B2, October 2, 2012 "Powertrain, Vehicle, and Method with Electric Motors and Dual Belt Drive", N. Hannemann, J. Scarbo, D. Hartland, and R. Wicks

SAE: Professional Development Programs

- "Selective Catalytic Reduction for Diesel Engines" 2014

- “Side Impact Occupant Safety and CAE” 2016
- “ADAS Application: Automotive Emergency Braking” 2017
- “Introduction to Highly Automated Vehicles Seminar” 2017

FACT

Fee Schedule

Hourly Rates

<i>Neil E. Hannemann</i>	\$345
<i>Richard A. Hille</i>	\$245
Administrative	\$80

EXPENSES (Incurred as a result of authorized activities)

All ordinary and necessary costs are billed at our cost. Automobile mileage is billed at \$.55/per mile.

Hourly rates are subject to revision in the event that FACT has a general fee increase.

Neil Hannemann				
List of deposition or trial testimony for the past 4 years				
Date	Case	Attorney	Court	
June 23 - 24, 2014	Warren v. Ari Makinen Enterprises	Craig Peters	Superior Court of California, County of El Dorado, SC100118	Trial
July 10, 2014	Chang v. Mazda	Jeffrey Asperger	Circuit Court of Cook County 2009 L 003095	Deposition
August 25, 2014	Engheta v. Lamborghini	Corey Arzoumanion	Superior Court of the State of California County of Los AngelesPC 050804	Deposition
October 17, 2014	Lipscomb v. Toyota	Todd Tracy	U. S. District Court for the Western District of Texas, Waco Division	Deposition
November 12, 2014	Mantanona v. Dorel	Todd Tracy	District Court, Coleman County, Texas 42nd Judicial District Court	Deposition
January 12, 2015	Anton v General Motors	Linda Williamson	Superior Court of the State of Arizona, Maricopa County CV2012-017597	Deposition
February 4, 2015	Saylor v. Bob Baker Lexus	Shane Biornstad	Superior Court of the State of California, County of Los Angeles, JCCP 4621	Deposition
March 3, 2015	Engheta v. Lamborghini	Corey Arzoumanian	Superior Court of the State of California County of Los AngelesPC 050804	Deposition
April 7, 2015	Ford v. Paice LLC	Brian Livedalen	U.S. Patent and Trademark Office, IPR 2014-00570, IPR 2014-00571, IPR 2014-00579	Deposition
April 8, 2015	Ford v. Paice LLC	Peter Guarnieri	U.S. Patent and Trademark Office, IPR 2014-00570, IPR 2014-00571, IPR 2014-00579	Deposition
April 30, 2015	Ford v. Paice LLC	Brian Livedalen	U.S. Patent and Trademark Office, IPR 2014-00875	Deposition
April 30, 2015	Ford v. Paice LLC	Brian Livedalen	U.S. Patent and Trademark Office, IPR 2014-00904	Deposition
May 1, 2015	Ford v. Paice LLC	Peter Guarnieri	U.S. Patent and Trademark Office, IPR 2014-00884	Deposition
May 4, 2015	Melendres v. Nissan	Larry Coben	Superior Court of the State of Arizona, Maricopa County CV2011-054249	Deposition
May 5, 2015	Engheta v. Lamborghini	Corey Arzoumanian	Superior Court of the State of California County of Los AngelesPC 050804	Deposition

May 20, 2015	Melendres v. Nissan	Larry Coben	Superior Court of the State of Arizona, Maricopa County CV2011-054249	Deposition
May 21, 2015	Kramer v. Ford	Mary O'Neill	United States District Court District of Minnesota - 12-cv-1149	Deposition
July 17, 2015	Sachs v. Toyota	Gabe Barenfeld	Superior Court of the State of Calif, County of Los Angeles, BC443701	Deposition
July 21-22, 2015	Sachs v. Toyota	Gabe Barenfeld	Superior Court of the State of Calif, County of Los Angeles, BC443701	Trial
August 3, 2015	Jenks v. Toyota	Paul Whelan	Superior Court for the State of Washington, King County	Deposition
February 5, 2016	Nersesyan v. Callaham	Edward Freidberg	American Arbitration Accoc. Commercial Abritation Tribunal - 01-14-0000-3204	Deposition
February 17, 2016	Andrews v. Mazda	Tedra Hobson	U.S. District Court for the Northern District of Geroga, Atlanta Division - 1:14-CV-03432-WSD	Deposition
March 3, 2016	Geronga v.Accubuilt, Inc.	William Smith	Superior Court of the State of California for the County of San Mateo - CIV524896	Deposition
March 24, 2016	Jenks v. Ford	Edgar Heiskill, III	Circuit Court of Floyd County, Virginia	Deposition
April 29, 2016	Nersesyan v. Callaham	Edward Freidberg	American Arbitration Assoc., Commercial Arbitration Tribunal -01-14-0000-3204	Arbitration
May 9 and 10, 2016	Geronga v.Accubuilt, Inc.	William Smith	Superior Court of the State of California for the County of San Mateo - CIV524896	Trial
June 15, 2016	Lawshe v. Mortiz Caddilac	Todd Tracy	District Court, Tarrant County, Texas 236th Judicial District Court, 236-274469-14	Deposition
August 4, 2016	Kramer v. Ford	Edgar Heiskell	U.S. District Court for the District of Minnesota 12-1149- SRN/FLN	Trial
September 2, 2016	Looper v. FCA, Chrysler Group	David Stein	U.S. District Court Central District of Calif, Eastern Division 5:14-cv-00700-VAP-DTB	Deposition
October 13, 2016	Swalley v. Plasticolor	Phillip Kuri	Court of Common Pleas of Summit County, Ohio - CV 2-12- 09-5350	Deposition
December 7, 2016	Waggoner v. G.M.	Andrew Counts	District Court, Northern District of Texas Wichita Falls Division 7:16-cv 00021-0	Deposition

January 26, 2017	Thomason v. Toyota	Jonathan Altman	U.S. District Court, District of So. Carolina Greenville Division 6:14-cv-04896-BHH	Deposition
February 10, 2017	Woodall v. Hyundai	Andrew Counts	U.S. District Court for the Eastern District of Texas, Sherman Division	Deposition
February 22, 2017	Brewster v. Dorel Juvenile Group, Inc.	Bruce Petway	U.S. District Court for the Northern District of Alabama Middle Division - CV-15-HS-2285-M	Deposition
March 9, 2017	Hillard v. G.M.	Andrew Counts	U.S. District Court for the Eastern District of Texas Tyler Division	Deposition
March 17, 2017	Engheta v. Lamborghini	Corey Arzoumanian	Superior Court of the State of California County of Los Angeles PC 050804	Deposition
May 23, 2017	Cruz v. Nissan	Jerome Tapley	Superior Court of the State of California, for the County of Los Angeles - BC 493949	Deposition
May 30, 31, June 1, 2017	Davis v. Volkswagen	Larry Coben	In The Court of Common Pleas For the County of Lehigh - 2014-c-2951	Trial
June 27, 2017	Seebachan v. John Eagle Collision Ctr.	Todd Tracy	In The District Court, 192nd Judicial District, Dallas County, TX, DC-15-09782	Deposition
June 28, 2017	Demmons v. Toyota	Todd Tracy	U.S. District Court of Maine, 1:16-CV-00189-JAW	Deposition
July 17, 2017	Glenn v. Hyundai	Eric Gibbs	U.S. District Court, Central District of California, Southern Division, 8:15-CV-02052-DOC-KES	Deposition
July 14, 2017	Duran de Yopez v. Ford	Ricardo Garcia	District Court, Hidalgo County, TX, 332nd Judicial District, C-3505-14-F	Deposition
July 21, 2017	Wilkins v. General Motors	Robert Palmer	Circuit Court of Jefferson County, State of Missouri, 15JE-CC00705	Deposition
Sept. 26 & 27, 2017	Seebachan v. John Eagle Collision Ctr.	Todd Tracy	In The District Court, 192nd Judicial District, Dallas County, TX, DC-15-09782	Trial
October 25, 2017	Diederich v. Ford	Todd Tracy	U.S. District Court for the Eastern District Court for the Eastern District of Arkansas Western Division	Deposition
October 27, 2017	Deason, Dotson v. Ford	Todd Tracy	U. S. District Court for the Western District Court for the Western District of Texas, Austin Division	Deposition
November 15 & 16, 2017	Duran de Yopez v. Ford	Ricardo Garcia	District Court, Hidalgo County, TX, 332nd Judicial District, C-3505-14-F	Trial

January 8, 2018	Panarello v. FCA	Lance Ivey	Circuit Court of the 15th Judicial Circuit in and for Palm Beach County, Florida - 502016CA007383XXXXMBAA	Deposition
February 15, 2018	Kondash v. Kia	Jason Dennett	U.S. District Court, Southern District of Ohio Western Division, 1:15-CV-00506-SJD	Deposition
March 13, 2018	Aguirre v. Nissan	Roger Dreyer	Superior Court of the State of California, County of Yolo - P014-1385	Deposition
April 3, 2018	Berry v. FCA	Darryl Lewis	Circuit Court of the 7th Judicial Circuit in and for Volusia, Florida - 2016-11361-CIDL	Deposition
April 20 & 24, 2018	Aguirre v. Nissan	Roger Dreyer	Superior Court of the State of California, County of Yolo - P014-1385	Trial
May 2, 2018	Antonini v. Ford	Todd Tracy	U.S. District Court for the Middle District of Pennsylvania - 3:16-cv-02021-RDM	Deposition
May 4, 2018	Anderson v. FCA	Tom Willingham	U.S. District Court for the Middle District of Georgia Macon Division - 5:16-cv-00558-MTT	Deposition
May 18, 2018	Weams v. FCA	John Smith	U.S. District Court, Middle District of Louisiana No. 17-4-SDD-RLB	Deposition